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(H1) Public Health Surveillance in Low- and Middle-Income Countries

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The health of the people is really the foundation upon which all their happiness and all their powers as a state depend.

Benjamin Disraeli

(H2) Surveillance: a tool for measuring health outcomes

This chapter focuses on public health surveillance in the context of settings of low resources *(1)*. Other chapters in this book have discussed surveillance system design and implementation largely from the perspective of developed countries or settings of high resources. The steps of system design and the underlying principles of collecting information for action do not vary because of the amount of available resources; however, in situations with limited (or absent) resources, there are both unique needs and opportunities for innovation. We address both the similarities and differences in the design and implementation of surveillance systems in low- and middle-income settings and provide examples of how some of the problems have been overcome or mitigated.

Health programs seek to increase healthy behavior, increase access to quality care, and decrease death and illness and thereby improve the overall health status of the public. The most important information for targeting and measuring the effects of public health programs are health outcomes such as rates of morbidity and mortality, and health-related behaviors as diet, smoking, and use of seat belts. There are numerous reasons for collecting health-related information and the primary purposes may be divided into the following functional categories.

(H3) Assessing health and monitoring health status and health risks

Most often health status and risk are estimated by measuring the leading causes of disease and death in a population. These indicators may assist in following the health status or identifying priority goals for population health (e.g., *Healthy People 2010*) *(2)*. Internationally, the use of health indicators is very common and additional work with the data can allow calculation of disability adjusted life years (DALYs) or years of potential life lost (YPLL) *(3-4)*. In addition, periodic systematic surveys of behavioral risk factors tracking health determinants or behavior that influence health can be useful in targeting and evaluating programs. For example, in developing countries in which smoking rates have increased exponentially, there will be important changes in the risk of developing lung cancer and cardiovascular disease; HIV/AIDS programs often rely on behavioral risk factor surveys to establish program design and evaluation.

(H3) Following specific diseases events and trends

Tracking disease trends (particularly infectious diseases) has been the main reason surveillance systems have been instituted *(5)*. For epidemic-prone diseases, a single case (e.g., of cholera, plague, or viral hemorrhagic fever) may be reason for reporting and action. For endemic or less severe diseases, surveillance systems may involve setting thresholds for concern and action for selected diseases. For example, a given district may decide that twice the expected number of cases of malaria in a month may be reason to initiate investigation and control. The analysis of information from public health surveillance systems on an ongoing basis may provide the first clues to identifying and quantifying epidemics. Programs to eradicate polio (and previously smallpox) make extensive use of surveillance to monitor the progress toward reaching their goals *(6)*. Eradication programs must rely on surveillance, which becomes more important (and expensive) as the target disease approaches eradication *(7)*.

(H3) Planning, implementing, monitoring and evaluating health programs

In international health, management information refers to program management – not patient management. Public health programs, such as directly observed therapy for tuberculosis or maternal health programs, are designed to make implementations to reduce the burden of disease from specific causes. Information systems for low-income settings are often designed to provide information about the *inputs, processes* and *outcomes* of health programs. Input information refers to things such as financial and human resources used in programs. Process information systems measure things such as stocks of supplies, numbers of people treated, staff time, and costs that are useful to measure the processes of service delivery. Input and process information

is useful to track the processes involved in health programs and measure efficiency. If it is not explicitly considered in project design, lack of accurate and timely information on the processes and management of the program may be the step that limits and prevents the project from meeting its goals (See also Chapter 5). Outcome information measures the status of the population, for example rates of disease or behaviors affecting health. This information is essential for public health staff and planners to target interventions where they will do the most good and to monitor program effectiveness *(8)*.

(H3) Financial management and monitoring information

Financial information may be a subset of management information systems or these systems may be designed and managed separately. Financial information is often given high priority in high-income settings as it is linked with the funding of health services. Increasingly methods for obtaining financial information are sought for low- and middle-income settings to assist in prioritization and resource allocation. This type of information may come from a system of patient records or from systematic population-based surveys *(9*).

(H3) Research

Research is an important use of information and a core public health activity, but a secondary, use of the surveillance information. Surveillance information is a useful tool for generating hypotheses on causes of disease or risk factors, and it can also be used to test hypotheses about

the effects of interventions. However, the primary purpose of public health surveillance is to provide information needed to improve the public's health. Unfortunately, information systems too often attempt to add long-term research questions and objectives to surveillance systems; this practice can lead to inefficient systems that fail to meet either the needs of implementers and researchers. Research questions are better addressed directly by special studies or systems (See also chapter 12).

(H2) Costs of managing without reliable information on local outcomes

All of these reasons to collect information are valid, and each has a place in national information needs. Unfortunately, however, too often collection of information is viewed not as a priority but as a luxury. Developing and implementing useful information systems is a particular challenge in the resource-constrained environment of low- and middle-income countries. Many health conditions – diarrhea, malaria, pneumonia, and malnutrition – occur in settings with only rudimentary health care and few public health staff. Information systems that are poorly designed and implemented are the rule, and in settings where health resources and programs are severely constrained, the collection of information may seem beside the point. Additionally, too often most of the information budget has been spent on traditional systems (e.g., passive disease notification) that have been dysfunctional for years and may be poorly suited for current objectives (*10*). Since these systems are not perceived as useful to either planners or program managers, they encourage the view that health information is drain and impediment to successful implementation of control programs. Thus, health ministry personnel may not see the utility of establishing or re-engineering their surveillance systems (See also Chapter 8).

The result is that in situations of low resources, measurable health objectives often cannot be identified because high-quality, population-based data are often missing. Instead of local data, planners must rely on information from international and regional sources such as United Nations International Children's Emergency Fund (UNICEF), the World Health Organization (WHO), international conferences, non-governmental organizations, and population laboratories (e.g., International Center for Diarrheal Disease Research, Bangladesh). Although health problems are similar in many low-resource settings, relying on data from other countries can create major problems. For example, programs may be put in place that are not needed or no program may exist despite significant local need. Geographic differences in the impact of conditions associated with hepatitis B, iodine deficiency, HIV, tobacco use, or malaria can be significant. As an example, the need for country-specific data is illustrated by the finding of World Bank analysts that oral-rehydration therapy (ORT) in low-mortality environments is much less cost-effective than passive case detection and short-course chemotherapy for tuberculosis, whereas ORT in high-mortality environments is very cost-effective *(11-12*). Cost-effectiveness varies by a factor of 2 to 10, depending on the local situation.

(H2) Planning the public health information system in settings of low resources

Before the specific information system is designed, it is important to review what is known and undertake a thorough priority setting process that first characterizes the health status of the population and leads to the design and evaluation of effective public health programs. The

activities and the information to support them must be connected logically, otherwise, the system designed may be piecemeal. Although this process appears linear, in reality it is far more fluid and less orderly (Table 13-1).

The form of a surveillance system should depend on the function and objectives for collecting the data. Throughout the world, surveillance objectives should be based on health impact, feasibility and acceptability of the proposed intervention, and the cost-effectiveness of the intervention (See chapter 8). When well-designed, public health surveillance systems directly measure outcomes accurately and systematically, they become valuable tools for monitoring health programs *(13)*. The selection of those diseases that should be maintained under local surveillance involves balancing resources and costs *(14)*.

Decentralization of health systems and health sector reform are happening in nearly every country of the world *(15)*. The process of decentralization may range from complete transfer of decision-making and fiscal authority to almost no authority at local levels. These design decisions have enormous implications for health information and surveillance systems. Systems designed for centralized systems do not work well in the context of decentralization because the users and their needs are different. Unfortunately, the health system may be decentralized without planning for the new information needs. Outmoded systems persist and new needs remain unmet *(16)*.

Once there is agreement about the objectives of a system, the system should be planned specifically to efficiently and effectively to meet that objective. Simple systems are most successful, especially in low- and middle-income countries where financial and human resources are often severely limited. It is easy to overwhelm the capacity of the system to provide accurate information by creating a complex system to be implemented by people who have many other tasks. Trying to attain too many objectives often leads to confusion and failure. Actual integration of information systems is covered later in this chapter as well as Chapter 4 of this book, and is a priority for many countries.

Identifying measurable health objectives, assigning them priority, and then linking surveillance to those objectives is a priority activity both for the surveillance system and for health-system development in general *(11-12, 17)*. Linking surveillance to these ordered health objectives alleviates the pitfall of thinking of surveillance as just the reporting of disease. In fact, effective surveillance systems use information from multiple sources (such as sentinel sites, exit interviews, and regular surveys). Linking surveillance to objectives will help planners of the surveillance system to think creatively in efforts to build a surveillance system to measure all priority health objectives. Chapter 3 in this book describes data sources that can be used in building surveillance systems. When resources are constrained there may have to be increased use of alternative sources such as case reports, sentinel sites, exit interviews, and surveys rather than more costly comprehensive methods available in situations of high resources. It is noteworthy that using these data sources does not necessarily compromise the representativeness or utility of the information – if the system is well-designed and effectively implemented.

It is important to remember that public health surveillance systems exist *only* in the context of a functioning public health system. Surveillance should be put in place only when there is a planned or existing control program directed towards the health problem. The most important measure of a successful surveillance system is whether the information it provides is used by program managers to direct their work and improve public health. One way of considering the focus of information needs and objectives for a particular health problem is by looking at which cell of a two-by-two table best describes the situation (Table 13-2).

Surveillance through conventional disease reporting is most likely to be useful in those situations where the disease is described (etiology and transmission known) and there is some plan for taking action based on the information (cell A). Whereas the information or surveillance focus shifts more towards research and descriptive surveys when the disease is poorly described or control measures are unknown or not planned.

For each health objective, the method for tracking and evaluating that objective and its sub-objectives should be listed (Table 13-3). Once such a list is made, a grid can be constructed to show which method or approach will best measure the objective (Table 13-4). Completing a surveillance grid helps one visualize the overall structure and function of the surveillance system and think creatively about methods to obtain information.

The process of defining objectives, linking these objectives to indicators and then data sources and approaches will highlight surveillance needs. The process provides a basis for strengthening

existing components, for identifying existing information that could measure objectives, and to develop innovative new information system components. For example, in many countries, the process of linking surveillance to objectives highlights the need for mortality data and the absence of vital registration. In Table 13-4, the numerous potential uses of surveys as information sources is highlighted, which emphasizes their utility.

(H2) Data sources in international health

Chapter 3 describes specific sources of data for public health information and surveillance systems. There are certain additional sources specific to low- and middle-income settings that deserve mention.

(H3) Vital-event registration

The measurement of vital events is the most important single addition that developing countries can make to their existing surveillance system. Death and birth rates – along with cause-specific, age-specific, and gender-specific rates – are very useful. In the United States, for example, 13 of the18 health status indicators chosen to measure the health status of the population as part of the health objectives for the nation will be measured using vital records *(3)*. At the very least a methodology for tracking important causes of mortality, and using these data to infer important sources of morbidity and disability adjusted life years (DALY's) is fundamental.

Developing countries and donors have placed too little emphasis establishing or strengthening vital-event registration. In part these systems seem less exciting to outside donors or implementing agencies or they are perceived as too large and cumbersome. Vital registration could begin in small sentinel areas and expanded as it was evaluated and improved. The vital-registration system in the United States started in 1900 in 10 sentinel states, and it took 23 years for all states to be admitted into the system *(18)*. Obviously, in the early stages of setting up a registry, some births and deaths would be missed. As late as 1974-1977, 21% of neonatal deaths were not registered in Georgia *(19)*. Despite this under-registration, vital data are extremely useful. Once there is a system for collecting this information, the emphasis changes to slow, steady improvements in quality, completeness, and represenativeness.

In areas in which routine mortality data are not available, the verbal autopsy (in which trained or untrained workers take histories from family members to classify deaths by cause) is a useful technique *(20)*. In 1978, WHO detailed a list of approximately 150 causes of that could be used by non-physicians to classify deaths by cause *(21)*.

Included in vital registration are birth certificates. Reporting of births is directly linked to the extent to which births are attended, whether personnel are available to record these events, and whether reporting is linked with benefit. For example, if births are associated with receiving food supplements or any other positive outcome they are more likely to be reported.

In establishing vital-event systems, consideration should be given to including the registration of pregnancy. This is needed to measure the number of neonatal deaths, which in turn is needed to allow accurate infant-mortality rates to be calculated. Registration of pregnancies also allows measurement of prenatal care, fetal death associated with syphilis, family planning, and other important health concerns.

(H3) Regular, periodic surveys

Regular, periodic surveys can be an important component of a surveillance system. Surveys tend to be of two types: non-population-based focused surveys to address specific information needs for a topic or a geographic area or, larger, possibly population-based surveys. Non-population-based surveys might include periodic surveys of motorcycle helmet or automobile seatbelt to assist planning and managing injury control programs or the laboratory surveillance for antibiotic resistance in hospitals *(22*). The most common source of population-based information in low resource settings are cluster surveys – multi-stage surveys with primary sampling units *(23-24)*.

Surveys have generally been single-purpose and have been conducted intermittently on an as-needed basis, often at the request of international organizations. However, because the survey is the only method of gathering population-based information in many countries and surveys can be used to collect information on a variety of health topics, regularly scheduled surveys can constitute an excellent surveillance tool for health outcomes as well as determinants.

Previously conducted international or national surveys can serve as models for adaptation to local situations. Using questions and tools that have already been field tested may increase the quality of data collected and may allow for comparisons with other surveys. For example, WHO has useful questionnaires for diarrhea; acute respiratory-tract infections; immunization and knowledge, attitude, and behavior associated with HIV infection. The Centers for Disease Control and Prevention (CDC) has questionnaires that cover child mortality, health-station practices, nutrition, morbidity of all types, HIV risk behavior among youths, and others. Once questionnaire modules have been developed, each module should be field-tested for readiness for implementation. Advance preparation and testing are very important. It is difficult and time-consuming, and therefore expensive to develop an effective questionnaire. Unfortunately, too often many of these steps are skipped. This leads to large, impractical survey designs with poor quality assurance, questionnaires that are difficult to administer, questionable data that is often impossible to analyze, and useless results. A large sample size does not provide control for bias, poor quality assurance, and design. The only significant difference between a large biased survey and a small biased survey is that the large survey costs more. Small, well-designed and executed surveys are much more valuable for managers and do not divert resources from the implementations they are meant to support. Stories abound of large resources being spent on poorly translated data-collection tools that are culturally inappropriate, and that do not answer the information needs for which they were designed.

In the data collection tool (and the training to use it), it is advisable to reserve space for a small set (10 or so) of core questions that measure the highest-priority objectives for information

desired by high-level policy makers. Not only will this demonstrate the timeliness of this surveillance component, it might also facilitate political and financial support for its continuation. Finally, when the time comes for a survey, the survey coordinator puts together the core questions, the last-minute questions from the policy makers, and the appropriate survey modules.

Data collection desired by international organizations (donors and non-governmental organizations) can be integrated into the ministry of health's schedule of surveys. Coordination of the survey should include steps that integrate desired input (proposed modules or questions) to be used by multiple stakeholders. The two groups can then collaborate to determine how the needs of both groups could be met. The international group can help train survey-unit staff and can help maintain a training manual on designing and conducting a survey, including interviewing techniques. This method is a cost-effective way to build local capacity and facilitate sustainability.

(H3) Sentinel Surveillance

Surveillance that uses sentinel sites or providers can play a critical role in low-resource settings. At sentinel sites, more resources and more experienced and dedicated personnel can be used to collect information on more diseases, more detailed information about each case, and more difficult-to-collect information such as sexual behavior. Also, sentinel sites can often serve as

sources of information about new conditions and can be used to determine the most effective methods for obtaining new data for the routine collection system.

There are several potential problems in interpreting data from sentinel sites. Sentinel sites are not designed to be representative of the population. Often sentinel sites may be selected from hospitals or other sophisticated facilities and tend to serve urban patients. Such data will not reflect rural, small, non-urban health stations where the majority of the population may live. Consequently, as sentinel systems are piloted, rural and small health stations should be included the sentinel-site system.

Despite the lack of representativeness, for several reasons, sentinel sites areas can yield important information in a timely manner at a relatively low cost: first, cause-of-death data are available, permitting timely data collection and analysis; second, because the number of visits and deaths is large (as in large urban centers), they yield more precise estimates and allow subgroup analysis by age, gender, or other important variables. Also, data are currently available, whereas systems of vital events and regular, periodic surveys are not generally established. For example, in Kinshasa, the Zaire Ministry of Health used a hospital-based sentinel surveillance system to establish that measles remained an important cause of death for children <9 months old. The spread of clinically important resistance to chloroquine was detected because of increasing mortality from malaria in sentinel hospitals in numerous African countries *(25)*.

At local levels resource constraints limit the number of sentinel sites. However, both health stations and districts can conduct a form of sentinel surveillance by limiting data collection on some health problems to a small sample of sites at infrequent intervals. For example, although children have their growth monitored throughout the year, the percentage with weight-for-age of <80% of standard might be calculated only once every 3 months on a consecutive sample of 30 children.

(H3) Exit Interviews

Interviews of patients who have finished their visits at health facilities, which can be called "exit interviews," can be a flexible, easy, and cost-effective method of collecting information. Exit interviews are ideal for measuring progress toward local health objectives. They can be used to collect data for emergent problems or for routine surveillance, as well as to evaluate the performance of health workers and the management of the health services. For surveillance purposes, exit interviews can be used to collect information about the process indicators, health risks, health behavior, and health interventions (*26*). Unlike surveys, exit interviews can be conducted frequently.

(H3) Focus Groups and Case Control Studies

Focus groups can make important contributions to the design of a surveillance system and to the understanding of the information within the system (*27*). As complex issues such as changes in behavior are assigned higher health priorities (e.g., HIV-related behavior, diet, home fluids, treatment practices, and reasons for not being vaccinated), focus groups are often used to gain new information.

Focus groups often provide an appropriate first step in generating ideas about why events and behavior occur. After ideas or hypotheses are available, surveys, exit interviews, and special studies (case-control studies) can be used to identify specific factors that should be incorporated into surveillance systems. Health-facility staff can use focus groups, along with exit interviews, to measure health objectives of local importance.

Through focus groups, health workers can obtain qualitative information from the community, which may be widely defined to include key informants such as school nurses, leaders, or groups of mothers. For example, a focus group may help determine, from groups of mothers, why children are not being vaccinated and what might be done to solve this problem. Information on access to and demand for health care requires qualitative information for decision-making.

(H2) Specific issues related to implementing surveillance systems in low- and middle-income settings

The assessment of information systems in developing countries (settings of low resources) reveals characteristics similar to but exaggerated from those in developed countries including: a plethora of vertical systems, low response capacity, little analytic capacity, political decision-making and burdensome reporting requirements with no feedback *(10)*.

In this situation the best solution is to work with decision-makers and program managers to select and then carefully re-design and implement a surveillance system that directly improves the performance of a priority health program or activity. Actually seeing a useful surveillance system within their own setting is the most persuasive argument for surveillance for national health personnel.

The design of information systems for a specific purpose or objective must take the setting or situation into account. For example, the level of resources, security, geography, population dispersion and mobility, type of health system, literacy, centralization and privatization are examples. A complete description of the situation will help describe opportunities for information and constraints that must be considered (*28*). Increasingly tools for assessing and evaluating information systems are being developed by WHO, CDC, and others to better describe both the health care setting and the information systems in place and needs for strengthening. In low and middle-income settings an assessment of information systems most often reveals significant infrastructure and resource limitations that will affect the design and implementation of information systems. Typically, the categories of problems encountered are similar to high resource settings but more exaggerated. They include the following issues.

(H3) Limited personnel available for public health.

Compared with high resource settings, lower- and middle-income settings must often rely on clinical personnel to carry out public health functions. Training and personnel systems for medical personnel reward and emphasize clinical specialties and advanced diplomas in academic research. Thus, there is little incentive or skill in public health program management or information systems. The lack of incentives for public health work or public health staff includes numerous management and infrastructure problems that are difficult to address. For example, in many countries salaries for workers in the public sector are insufficient so they must work a second or third job, further impinging on the time available for public health activities. The lack of competitive salary and a defined career ladder means that ambitious and well-qualified staff are not retained. This leads to rapid staff turnover and system inefficiencies. Additionally, public sector jobs may involve inflexible civil service regulations or political considerations that do not reward performance. Because health information is viewed as not useful, top managers may place less-effective managers or staff in the health information systems on the principle that they will do less harm. Finally, the lack of supervision and continuing education for public health workers leaves them isolated. This leads to a downward spiral of worsening information quality and decreasing use.

Solutions to address the lack of personnel for public health and prevention have included voluntary systems (using community health workers, traditional birth attendants, or village volunteers) (ref UNICEF community surveillance). These voluntary systems deserve more

attention but must be undertaken carefully. Health workers in the formal system may have little familiarity with these programs or workers. Thus, they neither use them well nor respect their constraints or skills. Nevertheless, there are exciting opportunities in this area that can link community and health system resources *(29*).

More familiar solutions are public health training programs designed to meet human resource gaps either in numbers of personnel or in the types of skills they have *(30*). Typically this has been done either through short-term in-service training (particularly workshops) on public health surveillance or longer academic training programs. Short-term training has not shown significant benefit considering the amount of expenditure in time and funds. Too often these are implemented in a piecemeal fashion with little regard for actual adult learning techniques and behavior change. Long-term training is commonly criticized for the lack of applicability of academic graduates to public health systems and the lack of sustainability of the programs. These concerns have resulted in programs targeting the specific needs of public health agencies such as the Field Epidemiology Training Programs or Public Health Schools Without Walls *(31-32)*. In countries such as Thailand, Philippines, and Mexico, which have had these programs for 10-20 years, many top managers are either graduates of the programs or utilize information form graduates to make major decisions *(33*). These training program and the staff almost always work in re-forming surveillance systems to provide useful information systems leading to outbreak investigation and prevention and the production of health communication materials for various audiences.

One of the most important features differentiating successful from unsuccessful information systems is the presence of a supervision system. Technically credible supervision that occurs at regular intervals can make an enormous difference in the willingness and skill of health workers to participate in public health activities *(10, 34)*. There is much to be learned about addressing these problems however, it is quite likely that increased commitment to public health functions will be required both within ministries and the donor community.

(H3) Donor-driven development of surveillance systems

In resource constrained systems donors (multi-national, other governmental, private or others) may provide significant levels of funds for the health and public health system. In addition to funding, donors are important sources for new ideas and innovative methods. However, besides additional funding, donors bring a subset of challenges that the country must confront.

Donor reporting and accountability systems can add an extra layer of top-level bureaucracy that may complicate implementation. Donors have needs for data to monitor their own projects and may require ministries to develop and implement surveillance systems to gather this information. While information needed by donors for reporting may be similar to that needed by ministries for implementation, the data or timing requirements may be different. This creates an additional reporting burden for the health systems and can impede health delivery. Such systems create friction between donors and ministries and are not sustainable.

In addition, donor funding may be contingent on meeting 1-year targets that are not possible considering the difficulties of field implementation *(35*). Short time frames do not allow ministries to make the major changes in bureaucracy and infrastructure. High priority country programs may be put on hold to manage short-term projects.

Donors often require consultants to advise and assist ministry personnel in the design and implementation of projects. External consultants are expensive and may represent significant costs to the project. These costs are easily justified by good consultants who can catalyze the thinking and implementation of the project to help it move rapidly towards meeting its goals. Conversely, consultants with no experience may hinder implementation by insisting on impractical paradigms or, at best, must learn along with their counterparts. The ideal outside expert has successfully implemented a health information system in a ministry, has published or presented the results in a peer-reviewed context, and has a track record in successfully developing partnerships in low and middle income countries.

Non-governmental organizations (NGOs) have special benefits and risks. NGOs can provide essential support to the delivery of clinical and public health services in a country. Unfortunately, too often the ministry of health or other governmental agency or the donor does not provide the guidance to these organizations. The result is competition for resources that undermines the humanitarian goals. For example, an NGO may be charged with strengthening a

ministry of health. Because NGOs are typically able to pay much more than government agencies, the NGO may hire the best personnel away from the ministry it is trying to strengthen. Without careful planning for sustainability, these personnel may not be willing to re-enter the government at the end of the NGO project. If so, the ministry may actually be harmed.

Collaboration with the private sector and non-governmental agencies is essential in low resource settings. Governments can use their expertise, their willingness to work in the most difficult and under-served areas, their human capacity, and their low level of bureaucracy to get necessary information and improve health services of all types.

(H3) Multiple vertical ("stove-pipe") systems in place

Often an inventory of information systems reveals multiple systems that overlap but do not complement each other. What emerges are competing programs that mix objectives. For example, HIV/AIDS, polio, maternal and child health, sexually transmitted diseases, and the Expanded Programme for Immunisations, may each have single surveillance systems that do not link centrally and do not integrate resources. In an eradication campaign, great resources must be spent to identify the last few cases of a disease to be internationally certified and possibly leaving fewer resources for programs that are more cost effective in the short run *(36)*. However, with careful design, such systems can be developed and supported in ways that strengthen the ongoing systems and programs of ministries *(37)*.

Integrating information systems can increase efficiency of staff for public health and clinical functions, decrease the reporting burden, and allowing sharing of resources such as staff, cars, and computers. There are several advantages to integration:

- surveillance information can be gathered with greater cost-effeciency
- requirements for health facility staff will be simplified and their training will be less duplicative

Integration is a significant challenge because the real and perceived needs of different programs often require collection of vast amounts of data from different parts of the health system (clinic logs, accounting systems, central records) or from the general populations (incidence rates, behaviors) in differing time frames. Therefore, it is difficult to meet all needs with one instrument (See Chapter 4) *(38)*.

As an example, ministries in lower or middle income settings health management information systems often try use one system to measure management processes (such as stocks of vaccine in clinics) and public health outcomes (such as the incidence of cholera in the population.) Although the integration of systems appears logical and efficient, this combination is fraught with difficulties. A management process information system usually measures properties within health programs, while public health surveillance systems measure properties outside the health system and within the community (outcomes.) Both public health surveillance and management process information are needed by policy-makers, implementers, media, and the population to

make rational decisions about health. However, combining the two systems may lead to a complexity that seldom works well and does not enhance either objective, particularly when the persons collecting and managing the data do not understand the utility of and differences between the two types of information.

Integration usually occurs after the national system has struggled with multiple "independent" or vertical systems that have taxed resources and not effectively answered information needs. Therefore, the actual process involves bringing together existing systems with numerous stakeholders at all levels. This process is facilitated by identifying a group of credible experts at the top level who can work with program managers and local officials to coordinate activities and where feasible, combine them. If users of the information, such as program managers or local officials, do not feel ownership of an integrated system, it is likely that they will either continue to use old vertical systems or develop new ones that they feel give them control and meet their needs. Most countries end up with a mix of integrated and vertical information systems supplemented by periodic surveys. The more these activities can be coordinated, the more efficient they will be.

Beyond routine reporting systems it is necessary to coordinate and integrate other sources of information. For example, to assure the development of a useful national surveillance system in a developing country, a survey unit or committee should be assigned the task of coordinating all national health surveys. The unit first works with program staff to develop surveillance questions in high-priority areas (e.g., diarrhea, vaccinations, HIV/AIDS, family planning, child

survival, malaria, and tuberculosis). Two to five questions are often adequate for some conditions. The questions should be assigned priority so that the survey coordinator has some flexibility to shorten the overall questionnaire if needed.

More recently, in settings of low resources planners are looking to the integration of vertical programs to increase the personnel and the incentives that might be available for high priority diseases. For example, polio surveillance officers involved in the active surveillance of polio have begun to include other diseases including cholera, measles, and meningitis *(37)*. This increases local acceptability of these eradication programs and may lead to increased staff available for core public health functions in the lower and middle levels of the health system (health facilities and districts). The actual process of integration takes a high level commitment by decision-makers to allow sharing of resources (vehicles, staff time, and computers).

(H3) Lack of laboratory support for confirmation of outbreaks or for management of patients

In low-income settings laboratory services may be unavailable, non-standardized, and even the logistics of getting specimens to the laboratory are difficult. Laboratory diagnosis increases the specificity of the surveillance system. The polio eradication program has done innovative work towards trying to overcome many of these problems all over the world. For example, they have used the private sector to help transport specimens to the laboratory and the laboratory results

have been used to insure that the surveillance system results are supervised and accurate *(39*). Expanding the services of laboratory improvements built from vertical programs remains a significant challenge. Regional approaches, across national boundaries may be necessary to provide the laboratory services needed. Increasingly, national laboratories must provide guidance to laboratories within the country about core public health laboratory services.

(H3) Unsatisfactory response capability and system not held responsible for response

A culture of credibility for data or information must be combined with the belief that information is collected in order to take action. The design and implementation of surveillance systems needs to take into account the legal and administrative benefits and consequences of reporting. Countries may have elaborate regulations for reporting that are not practical to enforce. Physicians are often not trained about disease reporting. In addition, whether they work in public or private institutions, they often do not see that reporting disease has any benefit to themselves or anyone else and they rarely face consequences for not reporting. In the absence of action or at least feedback even when action is not possible, people lose interest in case notification. Lamden, in a study in the UK and Wales, described in a relatively resource rich setting, that notification of outbreak-prone diseases took on average 16 days to reach the person who could take action in controlling communicable disease *(16*). This significantly reduced their ability to respond effectively to outbreaks nor was there any consequence for this lack of timeliness to those who report.

In low-resource settings, outbreaks of infectious disease are seldom detected or responded to until late in the course of the outbreak – after media involvement and political consequences have occurred (See also Chapter 16). Health workers are rarely encouraged to report public health problems, and they seldom have the resources they believe are necessary to initiate action.

Integrated, well-thought-out surveillance at the health-station and health-center level warrants more focused attention; especially, data-collection, analysis, and dissemination of results as a basis for public health action. Surveillance responsibilities should be specified in employee work plans and completion of surveillance duties used to assess health-worker performance.

WHO has surveillance and evaluation training modules for vertical programs such as EPI and Control of Diarrheal Diseases (CDD), but there are few general surveillance training modules for district or health-station levels *(40-43)*. Local surveillance is critical because major health problems in developing countries require innovative public health action at the local level. Local surveillance and public health action based on surveillance may be less urgent for programs with high effectiveness and ease of administration, (e.g., vaccinations), or for programs that depend solely on the formal health-care system (e.g., acute respiratory infections or tuberculosis). However, local surveillance and linked public health action will be essential for most of the priority diseases (e.g., diarrhea, malaria, and HIV) and related prevention activities (oral rehydration solutions, chloroquine for all cases of fever, and condoms). In general, these interventions require extensive behavior change on the part of clients and also require local

problem-solving, surveillance of objectives, strategy reformulation, and creative intervention by health workers to be successful.

To address the usefulness of data at local levels data collected routinely by health stations should be limited to high priority conditions. For example, mandatory reporting could be limited to 10 selected diseases on the basis of established priorities or reporting laws. In addition, the health facility should meet certain standards before reporting requirements are expanded: the health station staff should be a) reporting regularly, b) displaying information collected, c) able to describe the meaning of the data, d) using the data to solve health problems with national and community input, and e) using the data to evaluate programs targeted at certain health problems. If these are all being done, the staff is likely to see the usefulness of surveillance information in program management and will likely be more enthusiastic about the public health functions and able to initiate collecting more information.

Many health facilities are limited to just reporting the number of cases of disease (i.e., summary-count data) via simple patient registers. As they become more able and interested, additional case-patient data (e.g., age and date of onset of disease) can be collected for selected health problems, and additional diseases can be added on the basis of priority setting (e.g., AIDS or moderate and severe malnutrition). The practice of collecting data intermittently for special purposes can be expanded, and data items found to be useful at sentinel sites can be added to reportable conditions from all health stations or at least can be expanded to a larger number of sentinel sites.

Display and interpretation of surveillance data and planned action based on the interpretation can be integrated into assigned duties of health workers and into the duties of their supervisors. Each health worker should have a detailed task analysis or job description, with the task analysis linked to national and local health objectives. Public health surveillance systems require good managers who understand how to use surveillance skills, quality assurance, and communications to bring the system to life and maximize its effectiveness as a tool to improve the health of the public.

(H3) Infrastructure and communications constraints

Lack of transportation for health staff to do public health work including the investigation of cases, contact tracing, control of disease, or for specimens to reach laboratories is frequently named as a significant constraint. For example, the lack of basic equipment and supplies represents another obstacle. In a recent survey in Tanzania many of the health facilities did not have reporting forms, and health personnel often had not been trained to use the forms for reporting diseases within the surveillance system (personal communication P. Nsubuga).

Electrical power may be available only erratically and, in some settings, not at all. There may be surges of power on the line that disable equipment or create errors in data bases In some places, there simply is not the resource or education base, or both, to create a computer-based system. In such settings, health workers may still rely on a paper-based on written reporting system. When this happens, it becomes even more challenging than usual to maintain quality control during the

collection and tabulation of data, as well as to stimulate review and use of the information created through analysis of the data collected. It may also be a challenge to convince officials higher up in the public health or governmental systems of the validity and value of information that appears on hand-lined paper in hand-written script.

Often computers are not available, and when they are, they may be old or inaccessible to those who need them. Frequently computers are viewed as status symbols resulting too often in inappropriate placement. For example, they may be available only to executives who neither need nor know how to use them while not available for data entry and analysis. More positively, the availability of computers in developing countries to analyze surveillance data and even to connect electronically at regional and international levels has increased markedly. As the prices of computer hardware have continued to decrease, computers have been moved to zonal, state, and provincial levels. In many countries surveillance data have been analyzed with computers at the national and district levels for several years. Increasingly countries are reporting data to WHO electronically. *Epi Info* is an epidemiology computer program designed to assist data management and analysis that is available free and over the Internet *(44)*. This program is available in seven languages (English, French, Spanish, and Arabic, Russian, Chinese, and Serbo-Croatian), and manuals are also available in Italian, Portuguese, German, Norwegian, Hungarian, Czech, Polish, Rumanian, Indonesian, and Farsi.

Mapping of surveillance data has increased because inexpensive mapping programs that can display maps by district, health station, and village and can be linked to surveillance data bases.

A mapping program called *Epi Map* is compatible with *Epi Info* and can create maps of surveillance data automatically (See Chapter 11).

(H2) Case study: An example of design and implementation of a surveillance system in a middle income country – characteristics of two surveillance systems in the Philippines

In 1989, the Philippine Department of Health (PDOH), concerned that epidemics that were reported via the media but were not identified by the health information system, reviewed reports and determined that fewer than 10 outbreaks were reported to the central level per year in a country of over 60 million people. PDOH then developed a sentinel surveillance system to provide early warning of outbreaks of selected infectious diseases. In its first year of operation, the system identified several outbreaks. One of these was an outbreak of tetanus that was traced to fireworks injuries in the annual New Year's celebration. Review of the causes of this outbreak led to the development of an injury-control program that reduced the numbers of injures and eliminated the unexpectedly high number of cases of tetanus *(45*). The surveillance system showed that a surprising number of children in the age range of 1 to 2 years were having measles. This discovery led to a change in policy that allowed children of this age to be vaccinated for measles. When Mount Pinatubo erupted in 1992, the National Epidemic Sentinel Surveillance System (NESSS) staff were mobilized to conduct daily surveillance on over 100,000 evacuees *(46*). The system was well established by 1995. In that year the NESSS detected 80 epidemics that were formally subsequently investigated *(47*). These included 25 outbreaks of bacteriologically confirmed typhoid fever; 15, of clinical dengue; 10 of clinical measles; seven of

food poisoning of unknown cause; five of laboratory-confirmed cholera; four of human rabies; three of malaria; two of mushroom poisoning; two of meningitis; two of paralytic shellfish poisoning; and one each of unspecified viral encephalitis, diphtheria, laboratory-confirmed chickungunya fever, leptospirosis, and puffer fish poisoning. All these outbreaks were investigated and in most cases control measures were implemented as a result of results reported by the investigators.

In 1990, in response to reports that many vertical health information systems were inefficient, the PDOH revised routine reporting by creating the Field Health Information System (FHSIS), a centrally-designed integrated information system, which aimed to integrate management information vital statistics, and notifiable diseases information systems. Because this system had the broad objectives of combining public health surveillance and process management information for many programs, it was instituted in all health facilities run by the government. Data tables were designed at the central level to make it easy for local health personnel to analyze their own information as well as to pass it to the provincial level, where data were computerized, reanalyzed, and sent upward. After a short period of pretests, the system was instituted nationwide. Unfortunately, the FHSIS fared less well than the NESSS. In the mid-nineties, the PDOH decentralized and the central budget was decreased. FHSIS staff were not able to adapt the system to decentralization; it increasingly difficult to get data from many independent health units, data quality was difficult to estimate, and reports to the central level mangers fell years behind. In early 1999, two of the authors (MEW, SMM) assessed parts of the Philippine health system including the FHSIS. About half of units of local governments they visited reported that

they found the FHSIS useful and said they were continuing to fill out the forms and analyze the information for program purposes at their level. The rest said they had abandoned the FHSIS altogether because it was an impractical system designed to meet the needs of central managers. At the central level, the most recent national report available covered the year 1995. Only 50 copies had been printed.

In contrast, throughout the 1990s, program managers and PDOH top management increasingly relied on the uninterrupted flow of sentinel surveillance data from the NESSS to estimate disease burden and to monitor program impact. The NESSS was gradually expanded to include surveillance for fireworks injuries (hospital-based), HIV infection (community-based), acute flaccid paralysis (AFP) and poliomyelitis (facility-based), and HIV behavioral risk factors (community-based). In 1999, the PDOH reorganized, and merged all population-based health information systems (including FHSIS) under the managers of the NESSS in the hope that the quality and timeliness of the other systems would rise to meet the levels achieved with the NESSS.

As described above, the NESSS and allied surveillance systems successfully met the needs of leaders of the PDOH and other constituents, while the FHSIS struggled to meet its objectives. Why do some systems succeed and others do not? One can identify some of the lessons by reviewing the steps in the implementation of the systems.

The first step in designing a surveillance system is to identify the objectives. Too often large integrated surveillance systems like the FHSIS have broad and ambitious objectives of integrating many process management, vital statistics, and reportable diseases activities into one system for an entire nation. These ambitious plans are seldom matched with sufficient resources, and the system struggles under unrealistic expectations and lack of focus. In contrast, the original objective of the Philippines NESSS was narrow – i.e., to identify large epidemics of acute infectious disease quickly enough to that appropriate public health interventions could applied promptly. It was much easier for the staff of the NESSS to focus their efforts on meeting their objective and thus to provide early successes that showed Department of Health management and other constituents that the system was useful and timely. It was then possible to build the NESSS into a more integrated system by adding tasks one at a time over a course of years as it moved from a facility-based include a community-based component. Gradual growth allowed constituents within the PDOH to accept and mold the system to their needs. It should be noted that the transition to expand to community-based sentinel surveillance allows the system to make better estimates of incidence and prevalence rates (which require population-based denominators) and increases the utility of the system as a tool to promote equity *(48)*.

The purpose of surveillance is to provide information needed by managers and other decision-makers. Thus, it is essential to design the system to provide information in a format that provides data users (epidemiologists and program managers), decision makers and policy setters with what they need – in a form and a format that they can readily understand and use. The NESSS system was designed by the staff of the Department of Health and Field Epidemiology

Training Program trainees. In contrast, large integrated information systems are often designed by computer specialists and systems analysts who are unfamiliar with the needs of decision-makers in the field. The problem is compounded if the designers are consultants from outside the system, which increases the chance that health personnel will assume the system is imposed on them from the outside. This makes it less likely that they will feel ownership and sustain the system after external funding is discontinued. Thus, it is very important to involve users in the design of an information system, especially in the definition of the data to be collected and the format in which the resulting information will be presented. This principle can be carried too far however. Systems designed with multiple objectives (researchers, program managers, donors) may end up either collecting so much information it is unwieldy and not useful by making compromises that meet the needs of no one.

It is easy for system designers to focus entirely on hard issues of data collection, tabulation, analysis, and reporting.

In middle- and low-income countries, donors often provide funding for projects, and those same donors are key consumers of surveillance and other health information. In the Philippines, donors were skeptical about the utility of the NESSS for PDOH and themselves, so they declined to provide funding for creating the sentinel surveillance system. So NESSS was funded with limited local funds; it had to be small and focused. As the system demonstrated its utility, PDOH top managers and donors gradually added funds for activities (such as HIV behavioral risk factor surveillance). The system grew incrementally. On the other hand, those same donors had felt the

need for higher-quality national data to use in monitoring their many projects; this perceived need was shared by PDOH top management. Therefore, the FHSIS was well funded at the start, but was required to cover the entire nation in a short period. With the funding came the need to meet donor agendas and to keep to what was – in retrospect – an impossibly tight time schedule to provide the national data that donors and top managers needed acutely. In the end, these tight deadlines made implementation of the broad-based system a formidable challenge.

Frequency of reporting depends on how often users need information. NESSS reports on epidemics had to be created and disseminated frequently to allow time to conduct investigations and to apply appropriate interventions in order to prevent future cases. In order to meet this need, the new system was designed to provide weekly reports. Because the FHSIS to be was a national system with many users, reports were planned for different levels at different times. This proved difficult in practice and reporting, especially at the national level and reports fell far behind schedule.

The larger the size of the population under surveillance, the slower will be the process of collection and analysis. This is a crucial trade-off in any surveillance activity. In order to provide weekly reports, the NESSS designers chose a sentinel design with 14 facilities. Because admissions to facilities may depend on changes in referral patterns or other factors in addition to rates of illness in the population, the NESSS data provide only very rough estimates of rates of illness in the population. The FHSIS mandate involved providing information on all health facilities so it covered all health units. Whereas the NESSS trade-off provided rapid reports

while sacrificing geographic completeness, the FHSIS design required geographic completeness. However, this large scale made implementation and quality control difficult. For broad geographic coverage of many variables, it is often most practical to depend on periodic surveys rather than on ongoing information system. In many cases, national surveys have proved to be more satisfactory sources of national estimates in the Philippines than has the FHSIS or the NESSS.

Designers of information systems are often faced with top managers or donors who demand information systems that are good, fast, and cheap. It is useful to draw these three attributes on a triangle and explain that it is practical to give provide any two sides, such as good and cheap or fast and good, but that it is very difficult to build a system that is good, fast, and cheap. This involves the decision-makers in the discussion about the trade-off that will inevitably have to be made in the system.

Important factors for the success of the NESS included its focus on designing the entire system around customer needs, emphasis on building and maintaining human capacity, and quality assurrance. As the NESSS developed, the staff designed each new system beginning with consideration of how the reports needed to be designed and delivered in order to meed the needs of the users and then worked backwards to design the system to produce these reports (Table 13-5).

System designers tend to focus on hard issues of data collection, flow, tabulation, analysis, and reporting. It is easy to forget that a surveillance system is made up of people. Its success and sustainability depend on the attitudes and competencies of the people running the system. High-quality ongoing training, supervision, and career paths for surveillance system staff are critical ingredients in successful information systems. As the NESSS was piloted, its managers realized the importance of a cadre of competent and dedicated people to run it. Too often, planners of surveillance systems focus on data and only realize the importance of good personnel after the system falters. NESSS built staff by developing competency-based training for the nurses, who supervised implementation of each site, and for data entry clerks. Analysis and reporting os surveillance data is not a trivial task. Successful surveillance systems provide training and quality assurance for analysis and reporting functions, which are typically done by professionals. The NESSS sponsors yearly meetings where surveillance staff meets and presents successes and problems. The system also includes ongoing monitoring and periodic external evaluations. In contrast, the FHSIS was severely constrained by limited funding for staff training and development. To meet this need, a project developed an innovative computer program was written to automate data analysis *(47*). This program used the metaphor of "a black box" into which clerks could enter data. The program analyzed the data and produced a variety of useful reports without the need of human analysis. While this was a cost effective way to provide reports, some health workers felt uneasy that they did not have access to their own data and they were unable to modify the analysis done by the program. Some seemed to feel that the program might replace rather than complement their own analyses. This decreased acceptance and use of the program.

Both NESSS and FHSIS successfully met many of their goals, but neither was able to meet all the information needs of the PDOH. Their experience illustrates several key points about successful surveillance systems:

- objectives are realistic, clear, and focused on providing the information needed to implement programs to improve public health;
- resources and expectations are realistic and balanced;
- stakeholders understand that all surveillance systems involve compromise and gradual improvement based on monitoring and evaluation;
- users are involved in the design of reports;
- processes for data collection are appropriate to the data;
- staff are involved in design of processes and monitoring;
- there is ongoing training and career development for staff at all levels (including those who analyze and report information, not just data entry clerks);
- ongoing monitoring is used to improve processes;
- periodic external evaluations are used to build the system and confirm its utility as a public health management tool.

(H2) Summary

The vision for surveillance systems in developing countries involves systems that are linked to health objectives, ordered by priority, limited in scope, and not burdensome at the health facility

level. These systems may involve not only innovative data sources and methods to deal with the resource constraints, but also the opportunities that come with increasing emphasis on decentralization. It is hoped that improvements will come in methods to obtain population-based data gathering from vital event registration and surveys. Donors and international agencies can be instrumental in assisting countries to strengthen their own capacity at gathering this type of information rather than creating multiple vertical systems that do not connect.

In implementing surveillance and health systems, developing counties can avoid the mistakes that industrialized countries have already made. These include poorly planned and fragmented surveillance systems, surveillance systems that are not linked to objectives, health objectives that are not explicit and that are often politicized, large divisions between curative and preventive medicine, and differences in health care in rural versus urban areas. Most important are the infrastructure and managerial supports that are necessary to motivate the personnel who run the system despite significant obstacles. Surveillance in developing countries is accompanied by numerous logistic problems but also presents unique opportunities. The careful setting of health priorities and the meticulous allocation of limited resources to the interests of the public's health can be the results of surveillance in such settings.

Surveillance data need to be collected based on the frequency of decision-making. For certain types of information every 3-5 years may be sufficient for the program needs. Health objectives provide national politicians and health leaders a plan to ensure the public's health. With a surveillance system that is linked to these objectives, leaders will be able to monitor progress

made toward meeting national objectives. With analysis and action at the district and health facility level, local health staff can take rapid and appropriate action.

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List of Tables:

Table 13-1: Activities needed to establish and manage health services for a country of population and the types and sources of information needed to support these activities.

Activities needed to establish and manage health services	**Types and sources of information needed to support these activities**
1. Characterize overall health status of population (age distribution, major causes of mortality and morbidity	Population-wide census and causes of mortality and morbidity i. Periodic community level verbal mortality and surveys. ii. Periodic health facility register or record review by agents iii. Regular reporting by health facilities and providers (complete vital record registration)
2. Determine health risks	Review of causes of morbidity and mortality for common risk factors Risk factor surveys
3. Rank health problems by health impact (severity, prevalence) to determine what health problems need to be addressed.	Priority-setting exercises
4. Characterize high priority health problems and disease determinants	Targeted surveys of health providers, survey of health registers of other records, population surveys of risk factors; director observational surveys of high risk populations and geographic areas
5. Based on scientific knowledge, identify effective interventions for health problems and local situation	Scientific literature and health experts Local studies and field trials
6. Determine resources needed to implement interventions	Survey of health care resources (facilities, supplies, trained staff, communications and transport Survey of community resources, activities and potential Evaluate health budget
7. Prioritize activities based on previous steps	Decision analysis Expert opinion Political consideration and organizational capacity
8. Based on priorities (step 7) develop plans to prevent, control and treat high priority health problems.	Health management literature Expert opinion Organizational capacity
9. Develop systems to manage and monitor delivery of prevention, control or treatment programs.	Individual and family health records Modules for i. Inventory of supplies ii. Tracking staff

	iii. Financial accounting

Table 13-2: Two-by-two table for decision-making on the focus of planned information systems for particular health problems with examples

	Disease well-understood	**Disease not well-understood**
Effective control available or in place	**Information focus:** Routine information to monitor disease trends. Management of health resources and programs **Examples:** Vaccination programs such as polio. Cervical cancer screening, early detection and treatment	**Information focus:** Maintain and monitor control program. Conduct research to answer issues of risk factors and etiology. **Examples:** Cardiovascular disease, the early days of HIV infection
No effective control program available or in place	**Information focus:** Monitor trends of disease. Conduct research on effective disease control or ways to deliver control program to target population **Examples:** Dengue hemorrhagic fever. Prenatal HIV transmission in low resource settings where cost of full treatment is prohibitive. Lung cancer prevention through behavioral modification to prevent teenage smoking initiation	**Information focus: Monitor trends.** Monitor trends. Conduct research to establish etiology and investigate effective control measures **Examples:** Buruli Ulcer, pancreatic cancer, asthma, Creutzfeld-Jacob disease

Table 13-3. Examples of objectives linked to surveillance components that will measure objectives.

Surveillance-linked objectives	
Objective or indicator	**Example of methods to obtain information that measures objective**
Priority area #1 – Reduce diarrhea morbidity and mortality	
• Health status – Reduce diarrhea mortality by 25% by 2010	• Vital-event registration in country or five sentinel areas
• Risk factor – Increase female literacy of 10- to 14-year-olds to 80% by 2010	• Regularly conducted community survey
.	
• Risk factor – Current drug resistant diarrheal disease at 2%. No increase in drug resistant infections.	• Monitor laboratory susceptibility for selected stool samples.
• Health activity – Increase to 90% the proportion of 0- to 4-year-olds given appropriate home fluids by 2010	• Regularly conducted health survey or exit interviews

Priority area #2 – Maternal morbidity and mortality

• Health status – Reduce maternal mortality by 25% by 2010	• Vital-event registration in country or five sentinel areas
• Health status – Reduce cases of maternal morbidity by 50% by 2010 compared with 2000	• Sentinel health facility system or targeted survey
• Health activity – Increase percentage of pregnant women receiving prenatal care to to 60% nationwide	• Regularly conducted community health survey
• Risk factor – Increase female literacy of 10- to 14-year-olds to 80% by 2010	• Regularly conducted community survey or national data
• Health activity – Increase to 70% the percentage of women giving birth with trained assistants.	• Community survey or exit interviews women at all health facilities in district twice per year.

Priority area #3 – Unintentional injury prevention. Reduce morbidity and mortality and better characterize injury risk by 2010.	
• Health status – Reduce Morbidity and mortality from unintentional injury	• Vital records with detailed cause of death reporting. Facility-based records, sentinel health facilities, emergency room surveys
• Risk factor – Describe major risk factors for unintentional injuries	• Review of records, community surveys, sentinel sites. Review of media reporting
• Health activity – increase and improve the quality of injury reporting	• Sentinel sites. Review of records
• Health activity – Increase the use of motorcycle helmets to 60%	• Exit interviews in affected areas. Regularly-conducted health survey. Exit interviews in selected areas. Observation.

Table 13-4. Grid to identify which surveillance component will measure a health objective in a hypothetical developing country.

Objectives	Population based			Non-Population based			
	Vital Registration	Disease reporting	Surveys	Surveys	Sentinel sites (either facility, laboratory, or health workers)	Laboratories	Special studies (i.e. exit interviews or others)
Priority area #1 – Reduce Diarrhea morbidity and mortality							
Reduce diarrhea mortality by 25% by 2010	x	x	x	x	x		
Increase female literacy of 10- to 14-year-olds to 80% by 1995			x			x	
No increase in drug resistant diarrheal disease.					x	x	x
Increase percentage of 0- to 4-year-olds given appropriate home fluids to 90% by 2010			x	x			x
Priority area #2 – Reduce maternal mortality and morbidity							
Reduce maternal mortality by 25% by 2010.	x	x	x	x	x		
Reduce maternal morbidity cases by 50% by 2000		x	x	x	x		
Increase percentage of pregnant women receiving prenatal care to 60% nationwide.			x	x			
Increase to 70% the percentage of women giving birth with trained assistants			x	x	x		x
Priority area #3 – Unintentional injury prevention. Reduce morbidity and mortality and better characterize injury risk by 2010.							
Reduce morbidity and mortality from unintentional injury	x		x	x			
Describe major risk factors for unintentional injuries			x	x	x		x
Increase and improve the quality of injury reporting	x				x		

Increase the use of motorcycle helmets to 60%			x	x			x

Community surveys may be population-based depending on the sampling technique. Special surveys may target specific topics, sites, or populations. For example, emergency rooms, observational studies of seat-belt use.

Table 13-5 Steps in the development of the Philippine National Epidemic Sentinel Surveillance System

Data Side	**Human Capacity Side**
1. Identify the health problems thought to cause burden of disease	Consult top managers, donors, international agencies, experts
2. Determine who will make interventions.	Involve users in design
3. Determine information users need to make interventions	Involve users in design
4. Decide how often decision-makers need reports	Involve users in design
5. Identify who collects, tabulates, analyzes, reports, disseminates information.	Identify manager, staff to analyze, report, and enter data
6. Design report	Involve users and staff in design
7. Make shell tables	Involve staff in design
8. Design questionnaire	Involve staff in design
9. Pilot questionnaire	Involve staff in implementation and evaluation
10. Pilot data flow and analysis	Involve staff in implementation and evaluation
11. Pilot system	Train staff in system and involve them in evaluation.
12. Run system	Involve staff in ongoing training and quality assurance monitoring
13. Evaluate system - Was information used? Is data and analysis of good quality?	Involve staff and users in design of external evaluation and in review of evaluator's report
14. Revise System	Involve staff and users